2011-02-09 Mu2e Instrumentation Meeting

Wednesday, February 09, 2011
3:50 PM

- **BPM Design Options**: There are three styles of BPM system that could be used in the Mu2e era, which I list below in order of cheapest to most expensive.
    - **Echotek Board and Transition Modules**
        - P1, P2, AP1 and AP3 BPMs already use this style of electronics and would need minimal modification.
        - There will be lots of spare electronics from the Tevatron and Recycler that could be used in Mu2e. This includes transition boards as well as the VME crates and controllers. Repurposing electronics that are no longer needed for collider operations, potentially makes the Echotek option the most economical upgrade path.
        - The largest effort would involve modifying transition boards moved to Mu2e.
            - Debuncher would get Recycler style transition boards
            - Accumulator would get MI style transition boards.
    - **MTA Style**
        - Sten (PPD) and Nathan (AD) developed this style of BPM electronics.
        - Used in Linac and MTA.
        - Low cost NIM module design
        - Would have to be modified in order to get TBT data.
        - The "Pizza Box" design is an implementation of this style of BPM repackaged to make it more economical with more current hardware.
    - **Homemade VME Design**
        - This is similar to the style of BPMs used in the Tevatron.
        - This is an inexpensive and flexible option; however, it is the most expensive option since all components would be designed and built from the ground up.
- **Debuncher Tune Measurement**: .
    - **Requirements**
        - Instrumentation needs to know the precise requirements for the tune measurement and how much the beam can be pinged.
        - Vladimir suggests that it would be good to know the Debuncher tune to 0.001.
    - **Option #1: Damper**
        - Can be sued to measure the tune continuously throughout the cycle
        - It is believed that the damper can be used to tickle the beam enough to get a good measurement, while not impacting beam so much that it impacts the quality of beam going to Mu2e.
        - There are different options for pinging the beam with the dampers. We can either resonantly ping the beam or do it with one big ping.
    - **Option #2: BPMs**
        - Can provide a much more precise measurement, but limited to one sample per cycle.
        - Requires that the beam be pinged.
            - We get this for free at first turn injection.
            - We can use the damper to ping the beam if the tune measurement is needed somewhere else.
            - Since we can use the dampers to ping the beam, we don't need to use a separate kicker.
    - **Option #3: Schottky**
        - The existing transverse Debuncher Schottky detectors were removed from the ring for aperture concerns.
        - In the Mu2e era, larger aperture Schottkys would likely be needed.
        - This option will likely not be fast enough to get a good tune measurement within a single cycle due to the small signal that is in part the result of being far from the revolution harmonic.

- ○ **Likely Solution:**
  - ▪ The most likely solution is to use two of the above options:
    - □ Use Option #1 to track the tunes on each resonant extraction to get a general idea of what the tunes are doing.
    - □ Use Option #2 when you need a precise measurement for studies or troubleshooting.
- • **BPM Survey**: Brian was asked to provide more information on the current BPMs including exact numbers of BPMs at each location and cabling.
  - ○ **Documentation**:   Page 11-22 in the Diagnostics chapter of the Pbar Rookie Book (http://www-drendel.fnal.gov/documents/private/2007-Pbar-Rookie-Book/Release-v2.0/VII.%20Diagnostics.pdf) has detailed information on each of the BPM systems used in Pbar.
  - ○ I have a collection of Mu2e Instrumentation Documentation at http://www-drendel.fnal.gov/Mu2e/Storage_Rings/Instrumentation/
  - ○ **Survey**:
    - ▪ I completed a survey of BPMs in the P1, P2, AP1, AP2, AP3, Accumulator, D/A and Debuncher.
    - ▪ Pictures of each BPM crate can be found at http://www-drendel.fnal.gov/Mu2e/Storage_Rings/Instrumentation/BPMS/Service-Building-Photos/
    - ▪ The results of the survey are listed below. For each beam line or ring, I have included the service building and rack location of each set of BPM electroinics as well as the number of BPMs at each location.
  - ○ **P1 Line BPMs**
    - ▪ Cable from tunnel: RG-8/RG-213
    - ▪ Echotek Style BPM Electronics
    - ▪ Electronics Location:
      - □ **MI-60S Service Building**
        - ◆ Rack MI60114
        - ◆ 15 BPMs (I:HP702 to I:VP714)
  - ○ **P2 Line BPMs**
    - ▪ Cable from tunnel: RG-8/RG-213
    - ▪ Echotek Style BPM Electronics
    - ▪ Electronics Location:
      - □ **F1 Service Building Electronics Room**
        - ◆ Rack F107
        - ◆ 9 BPMs (I:HPF11 to M:VPF18)
  - ○ **AP1 Line BPMs**
    - ▪ Cable from tunnel: RG-8/RG-213
    - ▪ Echotek Style BPM Electronics
    - ▪ Horizontal and vertical BPM at every quad.
    - ▪ Electronics Location:
      - □ **F23 Service Building**
        - ◆ Rack F23R09
        - ◆ 18 BPMs (I:HPF11 to M:VPF18)
        - ◆ Note: This crate also contains two AP3 BPMs (see below)
  - ○ **AP3 Line BPMs**
    - ▪ Cable from tunnel: Heliax/RG-213
    - ▪ Echotek Style BPM Electronics
    - ▪ Electronics Location:
      - □ **F23 Service Building**
        - ◆ Rack F23R09
        - ◆ 2 BPMs (D:BPH929 and D:BPV929)
        - ◆ Note: This crate also contains 18 AP1 BPMs (see above)
      - □ **F27 Service Building**
        - ◆ Rack F27R05
        - ◆ 10 BPMs (D:BPH90 to D:BPH928)

- □ **AP-30 Service Building**
  - ◆ Rack A33R03
  - ◆ 19 BPMs in two crates (BPH902 to BPH918)
- ○ **Accumulator BPMs**
  - ▪ Cable from tunnel: RG-213
  - ▪ There are a total of 90 BPMs, divided evenly into six BPM sectors of 15 BPMs each.   Each Pbar Rings service building has a set of BPMs electronics at each end of the building.
    - □ **AP-10 Service Building:**
      - ◆ A60 BPMs, Rack B11R08, 15 BPMs
      - ◆ A10 BPMs, Rack B16R04, 15 BPMs
    - □ **AP-30 Service Building:**
      - ◆ A20 BPMs, Rack B33R02, 15 BPMs
      - ◆ A30 BPMs, Rack B37R011, 15 BPMs
    - □ **AP-50 Service Building**
      - ◆ A40 BPMs, Rack B51R07, 15 BPMs
      - ◆ A50 BPMs, Rack B56R03, 15 BPMs.
- ○ **D/A BPMs**
  - ▪ Cable from tunnel: Heliax
  - ▪ Electronics: NIM with Downconverter Cards
  - ▪ **AP-10 Service Building**:
    - □ Rack A11R02
    - □ 7 BPMs (BPI801 to BPI807)
- ○ **Debuncher BPMs**
  - ▪ Cable from tunnel: Heliax
  - ▪ There are a total of 120 BPMs, divided evenly into six BPM sectors of 20 BPMs each.   Each Pbar Rings service building has a set of BPMs electronics at each end of the building.
    - □ **AP-10 Service Building:**
      - ◆ D60 BPMs, Rack A11R01, 20 BPMs
      - ◆ D10 BPMs, Rack A17R04, 20 BPMs
    - □ **AP-30 Service Building:**
      - ◆ D20 BPMs, Rack A33R01, 20 BPMs
      - ◆ D30 BPMs, Rack A35R06, 20 BPMs
    - □ **AP-50 Service Building**
      - ◆ D40 BPMs, Rack A53R01, 20 BPMs
      - ◆ D50 BPMs, Rack A57R06, 20 BPMs.
- ○ **AP2 Line BPMs**
  - ▪ Cable from tunnel: RG-213 and Heliax
  - ▪ Electronics: NIM with Downconverter Cards
  - ▪ Electronics Location:
    - □ **F27 Service Building**
      - ◆ Rack F27R04
      - ◆ 15 BPMs in two crates (BPV701 to BPV715)
    - □ **AP-50 Service Building**
      - ◆ Rack A53R03
      - ◆ 19 BPMs in two crates (BPH716 to BPV733)
- ○ **Mu2e Extraction Line**
  - ▪ New BPM electronics racks would be needed at AP30 and the Mu2e Experiment building.
  - ▪ Number and location of BPMs will come from Carol Johnstone.
- • **What's next?**
  - ○ Next we would like to get some basic costing that includes both M&S and labor costs.
  - ○ We can start with costing on the Eckotek option, since it appears to be the most economical, assuming we can repurpose the unused Collider operation electronics.
  - ○ Ideally, it would be nice to get costing on

- Least expensive option
- Most likely option
- Most expensive option